

Woodland Management and Public Good Outputs: Appraising the Trade-offs in English Woodlands

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Abstract This paper examines the trade-offs between woodland management for timber and public good outputs in English woodlands. Recent evidence suggests that some public good values may be declining as a result of a lack of woodland management. Such under-management has been attributed to the decline in timber values and reduction in the productivity of woodlands and forests for timber products. It is argued that assessing the management needs of woodlands in order to enhance public good outputs presents a complex challenge and often depends on a variety of factors, including location, type of woodland, age, condition, substitutability and ownership motivation. However, in most instances a moderate level of management (whether for timber or otherwise) is likely to be beneficial for public good outputs.

Keywords Non-market benefits · Market failure · Under-management · Wood products

Introduction

Based on work commissioned by the Forestry Commission and the Department for Environment, Food and Rural Affairs (DEFRA), a desk study was undertaken to examine the interactions between woodland management for timber and the public good outputs from forestry in England. The research was motivated by two unrelated observations: first, some forestry interests have argued that there appears to have been insufficient emphasis on the productive management of woodlands in recent strategic planning and policy making for English woodlands; and second, ecologists (e.g. Kirby et al. 2005) have suggested that lack of management of

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woodlands can be a contributory factor in the decline of some of the ecological public good values of woodlands. Kirby's observations challenge the notion that benign neglect allows a drift towards naturalness and enhanced public good values. Given that public good forest benefits are estimated to be worth approximately £1 billion annually in Britain (Willis et al. 2003), 86% of which is in England, the relationship between public good level and management regime can be seen to merit further exploration.

Two major policy questions arise from this. First, in terms of the provision of public goods, should policy-makers be concerned at the extent of under-management in woodland associated with the decline of production values? Second, if positive non-market values are associated with woodland management, how can more active management of woodland for timber and wood products best be stimulated, with the effect of increasing the flow of public goods?

This paper outlines the findings from a small research project on the public good benefits of forestry and the impacts of woodland management on those public goods. The next section discusses the methods used, followed by the theoretical concepts behind the study: total economic value (TEV) of forestry, joint production and the potential trade-offs between timber production and public good outputs. The evidence base relating to woodland management and public good outputs is then outlined. Finally, the findings and conclusions are summarised, and possible management regimes to balance the joint production of wood products and public good benefits are proposed.

Throughout this paper the term 'woodland management' is used to refer to the management of woodland for timber or woody fibre production, unless stated otherwise. For brevity, this has been abbreviated to woodland management for timber (WMFT). Although there are a number of other motivations for managing woodlands, such as sporting shooting, conservation or recreation, this study focuses on woodland management for wood products. WMFT is examined in existing woodlands only, without consideration of the value of creating new woodlands.

Research Method

The main research approach was to trawl academic, policy and grey literature on woodlands, relating particularly to England but with some broader consideration of the UK context. Only four public goods were considered: biodiversity, recreation, landscape and carbon sequestration, these having been identified by Willis et al. (2003) as having the highest value in terms of public good benefit (Table 1). While it is acknowledged that there are many other public goods resulting from woodland and forestry, the resources available for this study did not allow for a full consideration of these.

An expert workshop, attended by 29 participants in March 2006, was held to obtain feedback on a circulated draft of the literature review. Workshop participants represented a range of public and private forestry interests, including timber production, biodiversity, landscape, informal recreation and carbon sequestration.

Table 1 Annual and capitalised social and environmental benefits of forests in England (£ M, 2002 prices)

Environmental benefit category	Annual value	Capitalised value
Recreation	354.24	10,121
Landscape	123.92	3,541
Biodiversity	363.00	10,371
Carbon sequestration ^a	43.11	1,232
Air pollution absorption	0.28	8
Total	884.55	25,272

^a The benefit from carbon sequestration is particularly uncertain because future climate change impacts are extremely difficult to predict. A carbon sequestration value of £6.67/tC has been adopted, which is low when compared with the UK government's recommended central value for the social cost of carbon of £70/tC (2000 prices), increasing by £1 per year to 2030 (Clarkson and Deyes 2002) and the Stern review's figure of \$85 per tonne of CO₂ (Stern 2006)

Source: Willis et al. (2003)

This expert panel was invited to assess what the effects of varying management intensities are likely to be on public good values.

Theoretical Context of the Study

Economic theory provides a framework for assessing the total economic value of woodlands. Such an approach is useful in developing strategies for successfully delivering the multi-purpose objectives of sustainable forestry. An understanding of property rights and joint production issues in relation to forestry can enable enhanced consonance of private and public good.

Since the early 1980s there has been a growing awareness of the need for forests and woodlands to provide not only timber, but other benefits including rural employment and non-wood goods such as recreation, biodiversity and pollution control. UK forest policy has evolved in response to the 1992 Earth Summit in Rio de Janeiro and subsequent Ministerial Conferences on the Protection of Forests in Europe which emphasised the development of national programs for sustainable forest management. The current UK forest policy is set out in the devolved national Forest Strategies, which outline the social, environmental and economic objectives of sustainable forest management (FC 1999, 2001, 2006). The strategies aim to deliver social and environmental benefits (public benefits) from forests and woodlands alongside economic benefits, including timber production. Sustainable forest management (SFM) is underpinned by the UK Forestry Standard which provides a benchmark for assessing the UK forest sector. Mechanisms to achieve this include the UK forest certification standard (the UK Woodland Assurance Scheme, UKWAS), which was developed through a consensus of owners, managers and other stakeholders.

Woodland grants and in particular the English Woodland Grant Scheme (EWGS) assist woodland owners in managing their woodlands to meet UKWAS standards

and to provide enhanced public good benefits. However, delivering multi-purpose forestry objectives presents challenges for policy-makers. This integrated approach to the multi-purpose forest resource requires finding the balance between the provision of non-marketable (or semi-marketable) public goods (environmental and social benefits) and private goods (e.g. timber production). This involves comparing a good with a market value (timber) to goods with no market value (e.g. biodiversity, recreation). This presents problems in terms of policy. If an economic value can be attributed to those public goods, they can be compared and valued alongside marketable goods. In the UK context, where the non-market values of woodlands often exceed the timber value, the potential benefits of such an approach become apparent.

The issue of property rights is also of fundamental importance in understanding both the nature of and solutions to environmental economic problems. If a private landowner has the rights to a water-course flowing across his or her land, including the notional right to pollute it, the strict neoclassical solution is to reward the provider for the good (not polluting the river) they provide to wider society. This latter course of action is termed the ‘provider paid principle’, in contrast to the ‘polluter pays principle’, and applies where a negative impact is being inflicted on the owner of a property right (for example, increased financial cost in preventing agricultural run-off into the river). In the case of woodlands, often the external benefits of public good provision can be internalised by the woodland owner. However, where this is not possible, there is an argument for government intervention in order to ensure continued provision of public benefits.

Joint Production of Woodland Outputs

The various outputs of forests and woodlands—timber, other wood or non-wood products and public goods—may be jointly produced. Joint production occurs when the production of one good results in the production of another (van Huylenbroek and Durand 2003). For example, rides¹ within a forest for accessibility of harvesting machinery can also be utilized as cycle tracks as a spin-off benefit. Figure 1 illustrates that an increase in the production of one good (forestry tracks for timber harvesting) can result in the production of another good (access for recreational use).

Often using resources for forest management in one way prevents them for being used in another way, especially when used intensively for one output. Thus, for example, a trade-off may occur whereby increased timber production causes a reduction in the production of biodiversity. Conversely, an increase in biodiversity may result in a decrease in timber production, and thus less profit. In practice, however, an increase in woodland management for timber may well (up to a particular point), be associated with an increased value for biodiversity (Fig. 2). This is the point on the curve where optimal joint production occurs in terms of maximizing public good benefits.

¹ A ride is a path or track through a woodland, often used for machine access or for recreation, especially horse riding.

Fig. 1 Joint production example of forestry rides and recreation

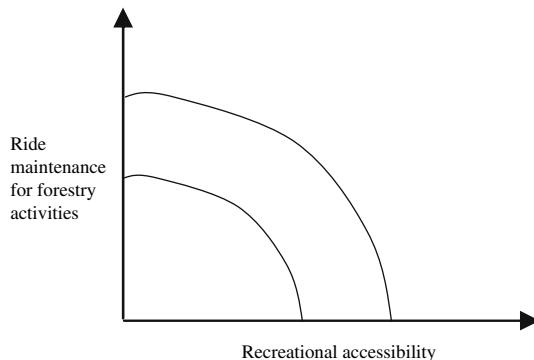
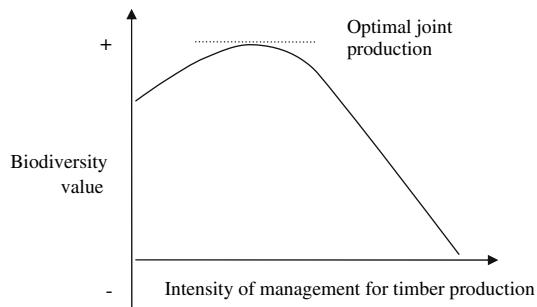


Fig. 2 The relationship between biodiversity and timber production, showing optimal joint production for public good provision



The Evidence Base for the Impact of Timber Management on Public Good Outputs

The total aggregate public good value of English woodland is largely dominated by recreational and biodiversity values, which collectively account for 81% of the non-market values (see Table 1). However, UK timber prices have fallen dramatically over the past 15 years and the UK only supplies about 19% of its requirement for timber, paper, boards and other wood products (FC 2005a). If wood production from forestry in England is not financially viable in much of the woodland and forest estate, this may result in forests that are either under-managed or unmanaged in relation to the public interest. This lack of management may have positive or negative impacts on public good outputs from forestry.

The Effect of Woodland Management on Biodiversity Values

Until the late 19th century (and much later in some areas), English woodlands were managed by coppicing, thinning, felling, pollarding and grazing, in order to provide fuel, small wood and timber (Rackham 1976). This diversity of demands created the structural heterogeneity and rich mix of species that are today associated with ancient woodlands. A survey of the long-term ecological change in British woodlands carried out between 1971 and 2001 revealed little difference in broadleaf

composition but some differences in woodland structure during this time (Kirby et al. 2005). In addition, over that time there was a decline in woodland specialist richness and ground flora richness which many consider represents a deterioration in the quality of biodiversity of woods (although the authors do not translate this into economic value changes). These authors stated that an increase in the total basal area of tree stems is closely correlated with this decline. The study indicated a decline in the openness of woods, particularly in large and small glades (clearings) and paths less than 5 m wide. WMFT may well help to ‘open up’ woodlands, and thus increase ground flora diversity. However, the observed declining biodiversity might simply be a phase in the even-aged development of woodlands. If left unmanaged, natural processes will eventually take over and may well balance out the shade and light conditions within the woodlands without the need for human interference. Such processes may occur over decades, with a change from species typical of managed woodlands to those associated with mature old-growth forests (Peterken and Backmeroff 1988). However, there are risks with relying on this process if most woods at the landscape scale are at a similar (shaded) stage as this limits the range of habitat types available.

Recent analysis indicates that populations of British butterfly species are declining more rapidly than either birds or plants (Thomas et al. 2004). The decline of the Dingy Skipper (*Erynnis tages*) has been linked to changes in woodland management which lead to shadier woods and a lack of open areas. Conversely, shade tolerant species—including the Silver-washed Fritillary (*Argynnis paphia*), the Speckled Wood (*Pararge aegeria*) and the Purple Hairstreak (*Neozephyrus quercus*)—have increased their range (Liley et al. 2004), most likely due to the increase in shady woodland habitats resulting from a lack of management. The most threatened butterfly species are those that require early successional habitats such as newly cleared or felled areas (Asher et al. 2001; Warren et al. 2001).

These habitat changes to shadier conditions may benefit some species (particularly those inhabiting fallen dead wood or shade-loving species), while having a negative effect on much ground flora. Thus, managing woodland with biodiversity objectives in mind should involve providing a range of habitats and structures that favour most species. Studies of appropriate habitat types and management for particular species include a Forestry Commission study (FC 2005b) on bats, Fuller et al. (2001) and Amar et al. (2006) on birds, and Tudor et al. (2004) and Grundel et al. (1998) on butterflies.

Much of the debate about changing biodiversity values has not been couched in the language of public goods or premised on an economic model of biodiversity loss. Indeed, many of the claims of loss of value relate to intrinsic rather than economic value. While recognising that intrinsic value is important, ascribing market values to biodiversity can enable policy-makers to compare much of the value of biodiversity with market values, thus affording it greater recognition than may otherwise occur. For example, an estimate of the non-use values of biodiversity (e.g. nutrient cycling, soil formation, watershed protection, waste disposal, pollination, oxygen production, climate regulation) globally is \$16–54 trillion per year (Costanza et al. 1997), compared with global annual GDP of about \$41 trillion.

The Effect of Woodland Management on Recreational Values

The TNS Travel and Tourism (2004) omnibus survey estimated that there were 222 million visitors to woodlands in England in 2004, 21% (46.62 million) of who visited FC woods, 33% to local authority woods, 23% to private woods and 7% to woods owned by voluntary organisations (NGOs). This estimate is much higher than that of Benson and Willis (1992), of 21.5 million visits to FC woods in England in 1992. Benson and Willis (1992) also indicated that the location of woodlands is a major determinant of the value of recreation, with more accessible and therefore more utilized forest areas having a higher public value. Table 2 indicates that those woodlands that are closer to urban areas and experience higher visitor numbers have a higher recreational value than more remote, less visited woodlands.

Forest recreation levels, and by implication values, are highly spatially-dependent. Woodland users prefer woodland close to where they live (Harrison et al. 1995; Coles and Bussey 2000; Ward Thompson et al. 2005). Scale is also important, with a suggestion that a minimum of 2 ha is required to enhance social value (Coles and Bussey 2000). Woodlands with an open structure and a mixture of species are preferred for recreation (Coles and Bussey 2000). Access to green space, including woodlands, can contribute to the quality of life and well-being of individuals (Kaplan and Kaplan 1989; Berger 1996; Hickman et al. 1999). However, there are also issues of feelings of insecurity in woodlands, relating to fears of personal attack or injury (Burgess et al. 1988; Fisher and Nasar 1992; Burgess 1995). A survey of woodland sites for the Forestry Commission in 2001 revealed that over three-quarters of the respondents expressed a preference for toilet facilities at woodland sites (Heggie 2001). The majority also wished to see sign-posted walks suitable for all abilities, a car park, nature trails and a picnic area.

The literature reveals a general desire for a mix between wild woodland and 'parkland' woodland (woods and pasture), partly managed but also with a natural 'feel'. However, such a woodland does not necessarily need to be provided through management for timber production of course. However, modest management for timber or wood products can help to offset the costs of management and, thus, owners may be able to internalise the delivery of recreational benefits. Conversely, some types of management for informal recreation may well contribute beneficially to wood production.

Table 2 Estimates in the value on recreation across the UK

Region	Value (£/ha/year)
Cheshire, England	445
New Forest , England	425
Forest of Dean, England	245
Brecon, Wales	42
Thetford, England	14
Newton Stewart, Scotland	4
Lorne (Argyll), Scotland	2

Source: Willis and Garrod (1991)

The Effect of Woodland Management on Landscape Values

Woodlands and forests can have a major impact on landscape values. They are important elements in greening urban environments, screening (noise and visual), improving human well-being and contributing to sense of place and quality of life. The landscape value of woodlands is also highly spatially dependent, being much higher in urbanised areas than in remote rural areas (CJC Consulting, 2005). Willis et al. (2003) estimated a value of £269 per annum per household for those households with a woodland landscape view on the urban fringe. Garrod (2003) estimated that on average households were willing to pay £226.56 per year for views of urban fringe broadleaved woodland on car journeys. Forested landscapes and local trees can also add value to house prices (Morales 1980; Anderson and Cordell 1988; Garrod and Willis 1992; Garrod 2003), although when there is over 20% general tree cover, they can reduce house values (Garrod and Willis 1992).

Studies in the USA show that clear-cutting has a major negative influence on the aesthetic appeal of landscapes (Ribe et al. 2002; Ribe and Matteson 2002) with an 'aesthetic dip' just after timber harvests (Ribe 1989; Sheppard et al. 2001). This is most likely due to people's preferences for natural landscape scenes (McCool et al. 1986; Magill 1992) and an aversion to the perceived destruction of life (Chokor and Mene 1992). In Karjalainen and Komulainen's (1999) study in Finland, landscapes without any traces of logging were preferred to those with evident felling areas.

Without timber harvesting, natural processes would eventually take over. However, the effects of the Great Storm of 1987 in southern England, in which about 15 million trees were lost and whole forests destroyed, illustrate the vulnerability of ageing woodlands to such climatic catastrophes. With the likelihood of an increase in frequency of such events associated with climate change, the under-managed state of many of England's woodlands may make them more vulnerable to storm damage, reducing their public good value.

The Effect of Woodland Management on Carbon Values

The estimated value of carbon sequestration is highly dependent on the price adopted per tonne of carbon sequestered (/tC) and the discount rate. The literature cites a range of carbon values between £2.66/tC (Pearce 2003) and £140/tC (Clarkson and Deyes 2002), and variations in the total annual value of carbon sequestration in Britain ranging from £94 million per year at £6.67/tC to £983 million at £70/tC (Willis et al. 2003; CJC Consulting 2005). At the higher level, the value of carbon sequestration in Britain is much higher than that of both biodiversity (£386 million) and recreation (£393 million) as estimated by Willis et al. (2003). The Stern review estimated the social cost of carbon at \$85 per tonne of carbon dioxide (Stern 2006). However, it is important to note that these limited analyses are restricted to the value of carbon associated with sequestration in living biomass, soils and wood products, and are most appropriate to studies of the benefits of woodland creation. They do not consider the carbon benefits that accrue from wood replacing fossil fuels directly in the form of woodfuel or, indirectly, by replacing construction materials, including concrete and steel, for which production

processes generate high CO₂ emissions. It is these substitution benefits that are likely to contribute most to arguments in favour of woodland management for carbon reduction objectives.

Many factors determine the rate of carbon sequestration by trees, including those pertaining to silviculture, site conditions and the age and vigour of the trees (Bateman and Lovett 2000; FTA 2004). Also, a trade-off exists between timber production and carbon sequestration. Liski et al. (2001) showed that regulating the rotation length of tree stands is an effective way to manage the carbon budget of forests. Longer rotations favour carbon sequestration. However, the private cost of this is decreased timber harvests, and thus decreased revenues to landowners (Liski et al. 2001). Earlier studies (e.g. those reported by van Kooten et al. 1995) also indicate that carbon sequestration is increased with longer rotations.

Almost half of British carbon value of trees is in Scotland (£2.6 billion) (Brainard et al. 2003). Apart from Scotland, carbon stocks (in tonnes per hectare) increase as one moves further south in England, with the south-east containing the highest carbon stocks (Brainard et al. 2003). This is because the south has more older, broadleaved trees later in rotations, whereas much of the stock in northern England is on peat or upland soils, which has been shown to have less carbon sequestration potential (Brainard et al. 2003).

Carbon values in existing woodlands could be enhanced through active management for wood fuel and for timber (as a substitute for concrete and steel). Such management could also increase recreational and biodiversity values if these are included as objectives in the management plan for the woodland. It should be noted that managing existing woodlands for woodfuel is different to the creation of plantations for the production of cellulose-based biofuels. Such plantations may compete with agriculture for land and necessarily be a monoculture in order to produce a large quantity of biofuel economically. It is likely that existing woodlands could contribute to woodfuel heating through the provision of logs and woodchip.

Determining Appropriate Levels of Woodland Management for Timber

The above review suggests that a moderate level of woodland management will in most instances enhance public good benefits. A lack of management has been cited as a contributory factor in the decline in biodiversity values in English woodlands (English Nature 2003; Kirby et al. 2005; Amar et al. 2006). However, management is likely to affect different public goods in different ways. In general, moderate activities such as thinning are usually beneficial in terms of enhancing public good provision in all woodland types (conifer, broadleaf and mixed), except in situations of wind-throw hazards or where there are special objectives or wilderness values to consider. Such management can enhance public good value, such as improving recreational access and increasing biodiversity.

The effects of different intensities of woodland management on public good outputs can be illustrated in terms of a production possibility curve. Figure 3 illustrates the likely production possibility scenarios for the four public good classes examined.

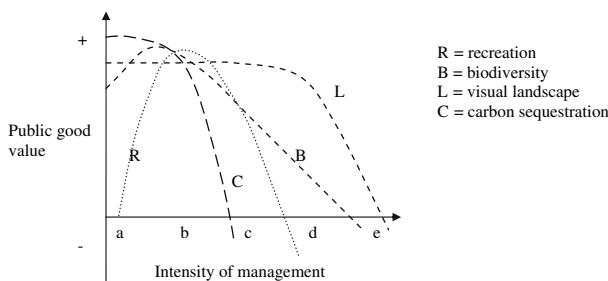


Fig. 3 Generalised relationships between public good values and management intensity

The literature suggests that there is an associated decline in biodiversity with a lack of woodland management. The location effects are largely irrelevant for non-use public good values for biodiversity. However, there may be some preference for accessible forests near to urban areas for those biodiversity values that have a use value (for example, bird watching or nature tourism). Hanley et al. (2002) (drawing on estimates from Garrod and Willis 1997) published the most comprehensive and inclusive assessment of non-use value of biodiversity in the UK. Their study revealed a preference for improving biodiversity values in new lowland broadleaved native woods and established upland native broadleaved woods.

Depending on the species or group of species for which a woodland is being managed, different types of management might be appropriate. It is likely that low intervention management regimes (single tree selection, small group-fell, thinning and removal of shade-tolerant conifers) are sufficient to increase biodiversity. Diversifying the structure of the canopy and understorey of an even-aged high forest by gap creation and thinning will enhance biodiversity. While intensive management generally has a negative effect on biodiversity, some wildlife species require clearfell habitats (e.g. the wood lark) and in these instances clearfell management may be the most appropriate regime if the focus is single species conservation (but with retention of some deadwood and veteran trees). Coppicing can also substantially increase the biodiversity value of woodlands, especially those that have traditionally been managed in this way (e.g. sweet chestnut and hornbeam woodlands in the south of England). Conversely, maintaining small areas of undisturbed canopy, of up to 2 ha, will provide a temporary habitat for bryophytes (mosses and liverworts) (Fenton and Frego 2005), lichens, fungi, invertebrates, small mammals and birds, and encourage their dispersal (Humphrey 2005; Nelson and Halpern 2005). Thus, each woodland will require its own management plan which specifies the target species for action.

For recreation, the public good value will normally be low, or even negative, where no management occurs (except for the minority of users with a preference for 'wildwood'), especially where the lack of management prevents access (e.g. overgrown footpaths). Public good value increases with modest levels of management, such as ride cutting, some thinning or small group-fell, but decreases again when management levels intensify (such as large-scale clearfell). However, as Willis and Garrod (1991) have shown, recreational values are highly spatially

determined, with woodland areas close to urban areas being of much higher value than more remote rural woodlands. Mixed or broadleaved woodlands are preferred over conifers for recreational use. This would suggest that lowland broadleaved woodland has the highest recreational value and should be the focus for recreational management, although there are exceptions, e.g. upland sites are more suitable for mountain biking.

The availability of alternative recreational sites (woodland or other green space) also determines the recreational public good value of a particular woodland. A woodland close to an urban area where there are no other areas of public open space will be of higher value than a woodland surrounded by other areas of public open space. Thus, those woodlands close to urban areas that are non-substitutable by other areas of recreational space should be considered as priorities for recreational public good enhancement.

In general, low to moderate levels of management will have no effect on large-scale landscape values. In contrast, large-scale clearfell can have a negative effect on landscape, albeit for a relatively short time. Negative impacts of clearfell can largely be mitigated by careful harvest design. In some instances, clearfell can improve the visual landscape by opening up vistas. Landscape values within the woodland (such as woodland rides, clearings or riparian features) can also be improved by management activities.

Carbon sequestration is perhaps the most complex of all woodland public goods in terms of determining appropriate management regimes. Non-intervention old-growth forests appear to have the highest value in terms of stored carbon, with a reduction in carbon storage occurring as management intensifies and timber is removed and the soil disturbed. However, a managed woodland in which high-yield timber is harvested and re-planted may offer greatest overall benefits and provide substitution of fossil fuels and substitution of materials (particularly concrete or steel). The location of the woodland for the production of woodfuel or timber will determine the level of CO₂ emissions arising due to transport to consumers or sawmills. The carbon leakage during timber processing must also be considered when calculating its carbon sequestration value.

The evidence suggests that enhancing public good outputs through WMFT is most likely to have the largest effect and benefit in broadleaved woodland, mainly in lowland areas. Non-Forestry Commission ownership accounts for 82% of English forests and woodlands (FC 2005a). Of this, 60% is in private ownership and 76% of non-Forestry Commission woodland is broadleaved. Much of this private broadleaved forestry estate is located in the lowlands close to urban areas and so provides opportunities for delivering public good benefits. Overall, private woodlands also have almost three times the carbon sequestration value of the Forestry Commission estate (Brainard et al. 2003). However, private woodland owners are an increasingly heterogeneous group. Anecdotal evidence suggests that almost 50% of rural land purchasers have no previous experience of rural land management, yet the motives for owning woodland are weakly researched (Slee 2005). Further investigation is needed on the motivations of private woodland owners in order to guide forest policy in enhancing public good benefits from these woodlands.

A study undertaken in 2002 to investigate the attitudes and perceptions of private woodland owners to public access revealed that availability of grants related to the provision of public access was unlikely to attract a high uptake. The study suggested that there would be more positive attitudes towards grant aid that related to the broader motivations for improving woodland management (Church et al. 2005). While most of the woodland owners in the study had benign attitudes towards public access, with 80% already having public access in their woodlands, they were more interested in incentives to boost the commercial potential of their woodlands.

Conclusion

In general a moderate management regime—including thinning, single tree harvesting, small group-fell, alongside areas of non-intervention—is likely to optimise the joint production of public and private goods within woodlands and forests. However, in a situation where a large proportion of forests and woodlands are either under- or unmanaged, how can such management be stimulated?

One option for enhancing public good value in woodlands would be for government support of woodland management for public good outputs, for example, subsidies for ride cutting for access or thinning to allow light to reach the forest floor for biodiversity. Such intervention would increase public good outputs, although it would be required on a continuing basis in order to maintain the level of public good delivered. Further, state support of positional good (Hirsch 1976) woodland owners who own and manage woodlands for personal enjoyment or private consumption is questionable.

Alternatively, economic instruments can be used to internalise the externalities of public good provision. If providing increased public goods results in decreased revenues for the woodland owner, compensation is necessary to motivate the owner to manage the woodland appropriately. If, as has been shown, modest woodland management has a positive effect on public good enhancement, a cost-effective approach may be to stimulate an active wood product market, whether it be woodfuel or timber. A small investment by government—in the form of grants or loans or the provision of advice or subsidized training—could stimulate small-scale supply chains and enable the external benefits of public good provision to be internalised within wood production as a joint product. Such an approach could provide a win-win situation where the woodland owner receives an economic benefit from managing their woodland and public good benefits are increased.

Developing market mechanisms and policy options for encouraging the sustainable management of English woodlands involves understanding the woodland owner. With an increasingly diverse mix of traditional and new woodland owners, it is essential to explore further their motivations and attitudes towards public good provision. The findings from this study suggest that the types of moderate management that can enhance public good outputs are indeed the management activities that private woodland owners may desire to carry out anyway. However, their desire to manage their woodland may be tempered by limited resources, in part due to the lack of profit-making opportunities from their

woodland. The challenge is to find mechanisms to encourage enhanced woodland management that are practical, cost-effective and of benefit to the woodland owner as well as improving the provision of public goods.

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